Service.

Self-Study Programme 231

Euro On-Board Diagnostic System

For petrol engines

Design and Function

Now an integral part of emission control and monitoring in the USA, the On-Board Diagnostics (OBD II) system will also be introduced within the European Union under the name Euro-On-Board Diagnostics (EOBD) from 1st January, 2000. Initially, the system will be available for petrol engines only, however, a version for diesel engines will follow in the foreseeable future.

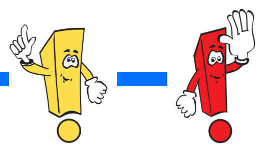
There are very few differences between European variant of this diagnostic system and US OBD II.

The only alterations made were those necessary to bring EOBD into line with European exhaust emission legislation. Other noteworthy features of EOBD are its central diagnosis interface and self-diagnosis fault warning lamp.

In this Self-Study Programme, we will show you new monitored vehicle systems and the associated diagnostics, taking Self-Study Programme 175 "On-Board Diagnostics II in the New Beetle (USA)" as the basis. In this way, you will not have to read through repetitive material.

NEW

Important Note



The Self-Study Programme presents the design and function of new developments.
The contents are not subject to updating!

Please always refer to the relevant Service Literature for current inspection, adjustment and repair instructions.

Table of contents

Introduction

Legal framework

On 13th October 1998, the European Union passed the EU Directive 98/69/EC, according to which the introduction of EOBD is mandatory for all member countries. This directive has been adopted into national law in the Federal Republic of Germany.

The introduction of EOBD is not directly coupled with an exhaust emission standard of the European Union (EU II, EU III, EU IV) or the Federal Republic of Germany (D2, D3, D4). Therefore, the target date for the introduction of OEBD and the associated transition period must be considered independently of the various exhaust emission standards.

Target date for introduction of EOBD

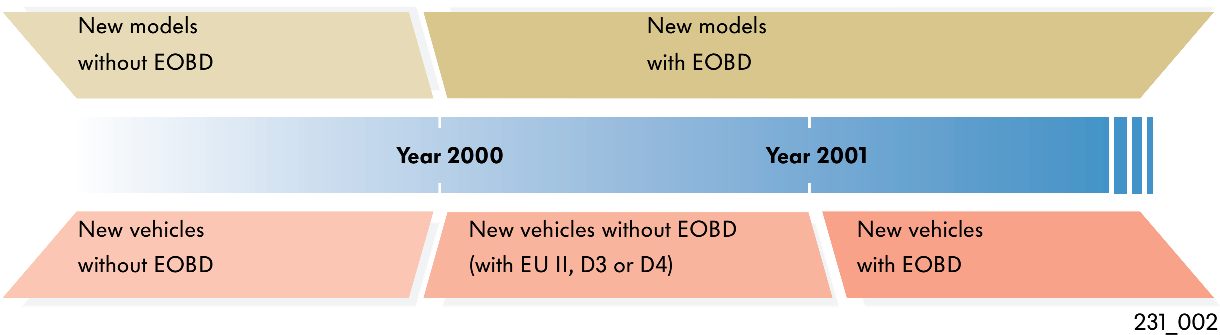
With effect from the 1st January, 2000, the automobile industry will be required to perform only one type test for new petrol-engined models if they have EOBD.

Transition period

The transition period pertains to models which have been type-tested prior to 31st December, 1999 and meet the EU II, D3 or D4 exhaust emission standard. The buyer may still register these vehicles until 31st December, 2000 and operate them without EOBD with no restrictions. With effect from this date, existing models will be required to have EOBD for initial registration purposes (buyer).

The EOBD legislation does not affect vehicles which were registered by the buyer prior to 31st December, 1999.

Type tests in the automobile industry



Homologation of new vehicles of buyers

Overview of EOBD

The visible elements of EOBD are the self-diagnosis fault warning lamp K83 and the diagnosis interface in the passenger cabin. The engine control unit performs all other functions and diagnostic operations automatically. The driver does not notice the ongoing checks on the systems in his vehicle which are relevant to exhaust emissions. This means that not much changes for the driver of a vehicle with EOBD, however service personnel will be required to familiarize themselves with new automotive technologies and the associated procedures.

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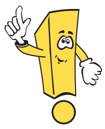
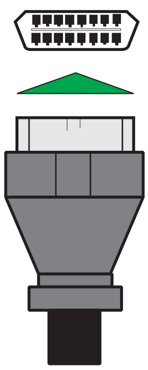


EOBD stores the "on" period of the self-diagnosis fault warning lamp (in terms of kilometres travelled).

Self-diagnosis fault warning lamp K83

If a fault impairing exhaust gas quality occurs on board the vehicle, the fault is saved to the fault memory and the self-diagnosis fault warning lamp is activated.

If there is a risk of catalyst damage due to misfiring, the self-diagnosis fault warning lamp flashes.



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Diagnosis interface

Stored EOBD data can be read out via the diagnosis interface. The fault codes are standardised so that data can be acquired using any Generic Scan Tool (OBD visual display unit).

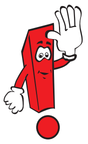
The diagnosis interface must be within easy reach of the driver's seat.

EOBD checks:

- The electrical functions of all components which are important for exhaust gas quality.
- The functioning of all vehicle systems which have a bearing on exhaust gas quality (e.g. lambda probes, secondary air system).
- The functioning of the catalyst.
- For misfiring.
- The CAN databus.
- For trouble-free operation of the automatic transmission.

New vehicle systems

Before we describe the details of EOBD to you, it is worth mentioning the new vehicle systems. Since the publication of the Self-Study Programme 175 "On-Board Diagnostics II in the New Beetle USA", several vehicle systems monitored by EOBD have been improved.



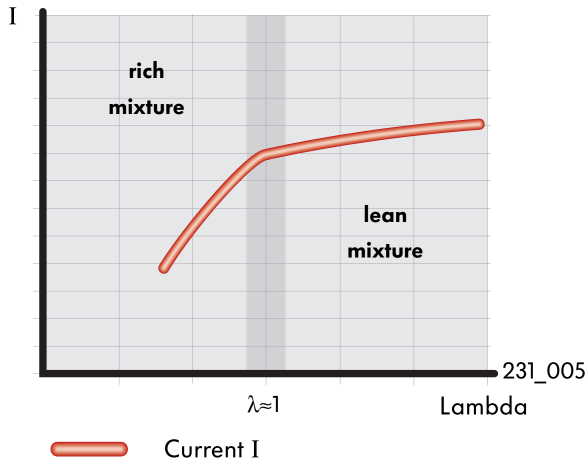
For functional descriptions of the vehicle systems which are not described in detail in this Self-Study programme, please refer to Self-Study Programme 175.

The broadband lambda probe

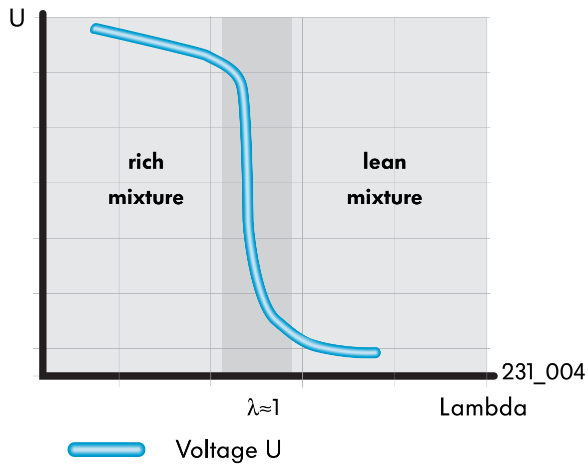
(LSU – Lambda Probe Universal) is a new generation of lambda probes that are deployed before the catalyst.
The name reveals the goals that were set for the development of this probe. The lambda value is represented by near-linear rises in current, and no longer by an abruptly rising voltage curve (which is the case with the step type lambda probe). As a result, it is possible to measure the lambda value over a larger measurement area (broader band).
The conventional finger probes (LSH – Lambda Probe Heating) or Planar Lambda Probe (LSF – Lambda Probe Flat) are also known as step probes because of their step-like voltage curves.

A step type lambda probe is used for the probe after the catalyst.
The step-like measurement area of a step type lambda probe around the value lambda=1 (λ=1) is sufficient for the probe after the catalyst to perform its monitoring function.

Broadband lambda probe



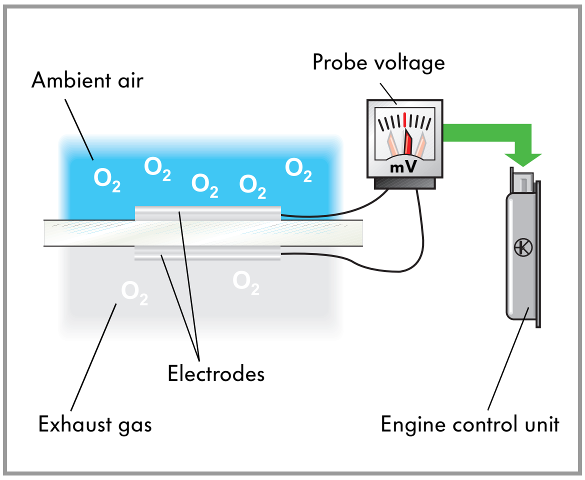
Step type lambda probe



Function

The broadband lambda probe acquires and evaluates lambda values differently to the step type lambda probe. Therefore, the lambda value is determined from a change of current, not from a change of voltage. However, the physical processes are identical.

To show the functional differences clearly, both systems are described briefly below.



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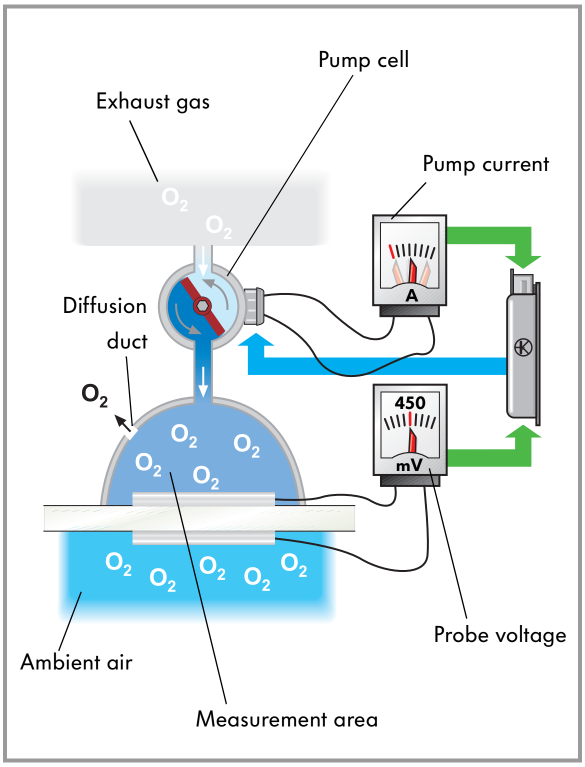
Step type lambda probe

The core of this probe is a ceramic body coated on both sides (Nernst cell). These coatings act as electrodes; one electrode layer is in contact with the ambient air and the other is in contact with the exhaust gas. The differential between the oxygen concentration in the ambient air and in the exhaust gas results in a voltage between the electrodes. This voltage is evaluated in the engine control unit in order to determine the lambda value.



231_033

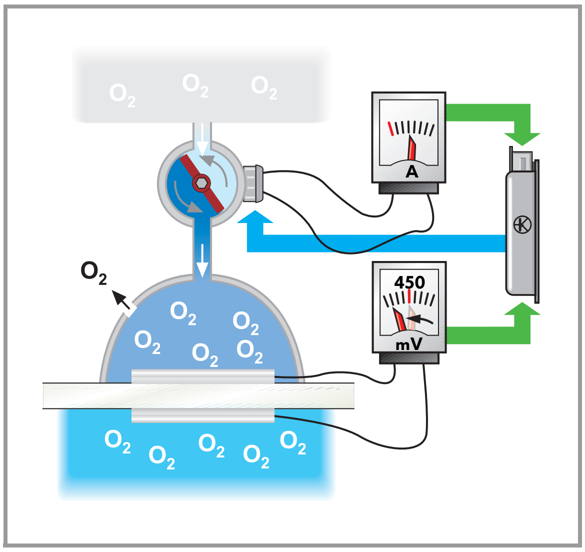
Broadband lambda probe

This probe also uses two electrodes to generate a voltage, which is the result of different oxygen concentrations. The difference to the step type lambda probe is that the voltage of the electrodes is kept constant. A pump cell (miniature pump) supplies the electrode on the exhaust side with enough oxygen to maintain a constant voltage of 450 mV between the two electrodes. The engine control unit converts the power consumption of the pump into a lambda value.

Introduction

- Examples showing how the broadband lambda probe is controlled

The fuel/air mixture is becoming leaner. This means that the oxygen content in the exhaust gas is rising and the pump cell, while operating at a constant delivery rate, is pumping more oxygen into the measurement space than can escape through the diffusion duct. As a result, the oxygen-to-ambient air ratio changes and the voltage between the electrodes drops.



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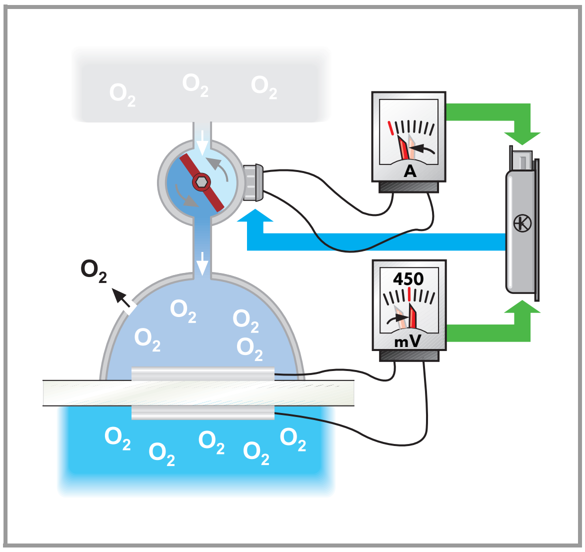
To restore the voltage between the electrodes to 450 mV, the oxygen content must be reduced on the exhaust side. To achieve this effect, the pump cell must pump less oxygen into the measurement space. The pump delivery rate, therefore, is reduced until the voltage is restored to 450 mV. The engine control unit converts the power consumption of the miniature pump into a lambda control value and alters the mixture composition accordingly.



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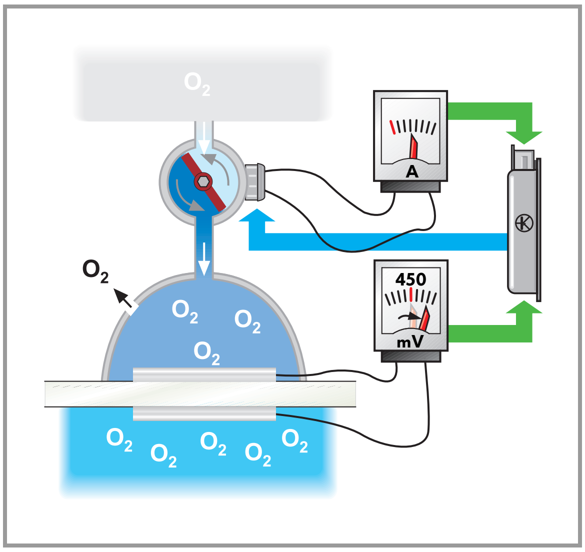

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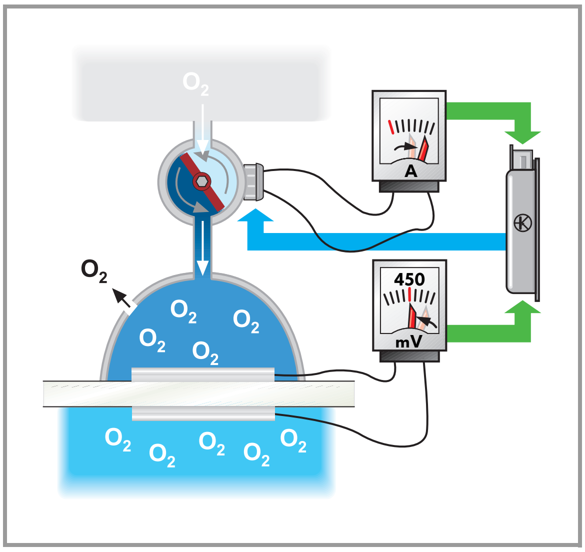
If the fuel/air mixture is too rich, the oxygen content in the exhaust gas drops. As a result, the pump cell, while operating at a constant delivery rate, is delivering less oxygen into the measuring area and the voltage between the electrodes is rising.
In this case, more oxygen is escaping through the diffusion duct than the pump cell can deliver.



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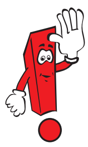
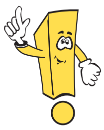
The delivery rate of the pump cell must be increased in order to increase the oxygen content in the measuring area. As a result, the electrode voltage is restored to 450 mV and the power consumption of the pump cell is converted into a lambda control value by the engine control unit.



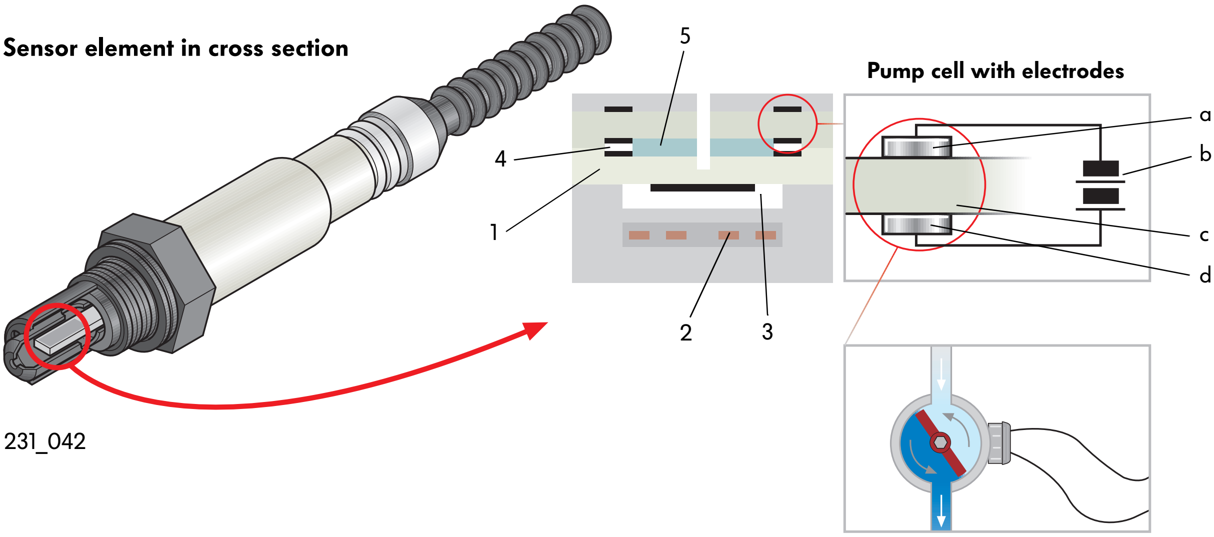
The pump action of the pump cell is a purely physical process. No mechanical components are used for the function. The pump cell is represented above symbolically.
A positive pump cell voltage attracts negative oxygen ions through the oxygen-permeable ceramic material.



The broadband lambda probe and the engine control unit are a single system. It is important that the lambda probe matches the engine control unit.

● Design

Sensor element in cross section



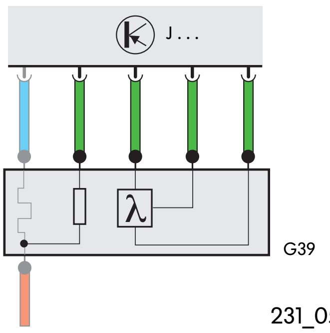
231_042

1 Nernst cell with electrodes
2 Probe heater
3 Ambient air duct
4 Measurement space
5 Diffusion duct

a Electrode (anode)
b Current source
c Ceramic material
d Electrode (cathode)

Two makes of lambda probe are fitted.

● Electrical circuit (NTK)



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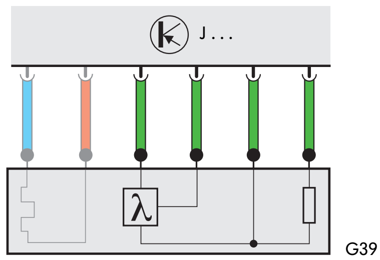
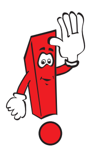
● Electrical circuit (Bosch)



231_059

● Effects of failure of probe before catalyst

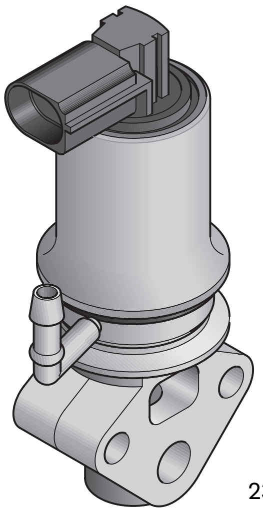
If the signal from the lambda probe fails, no lambda control takes place and lambda adaption is disabled.
The fuel tank purging system enters emergency running mode.
The secondary air and catalyst diagnoses are disabled.
The engine control unit uses a mapped control as an emergency function.



The broadband lambda probe may only be replaced complete with cable and connectors.

Electrical exhaust gas recirculation system

The exhaust gas recirculation system is primarily used to increase fuel efficiency in low-displacement engines.
As a result of the recirculating exhaust gases, the engine is required to induce less air. The resulting savings in suction work improve fuel efficiency.


231_046

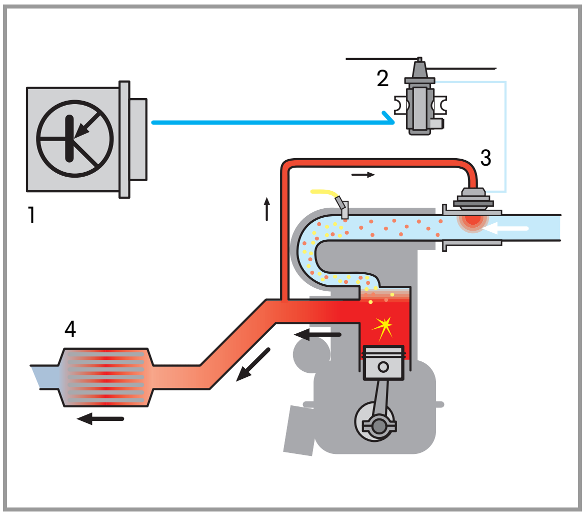
Exhaust gas recirculation valve N18 (new version)

- Function

Two valves were previously used to control the exhaust gas supply:

- Exhaust gas recirculation valve N18
- EGR valve

The EGR valve was activated electrically by the engine control unit and transferred a corresponding vacuum to the EGR valve.
The vacuum caused the EGR valve to open, allowing exhaust gas to enter the intake manifold.



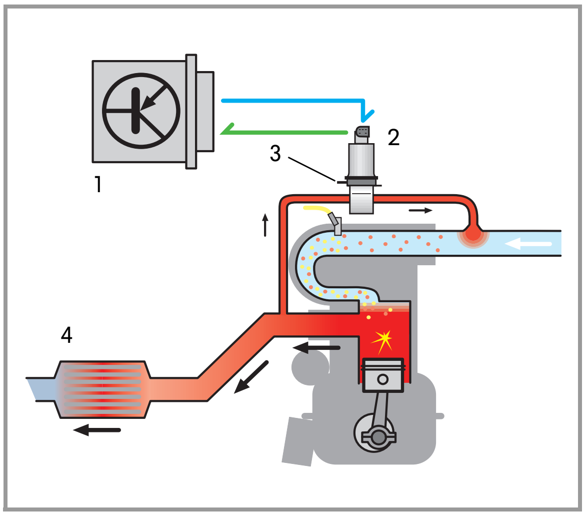
231_047

1 Engine control unit J...
2 Exhaust gas recirculation valve N18
3 EGR valve
4 Catalyst

Only one valve is still used for electrical exhaust gas recirculation:

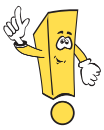
- Exhaust gas recirculation valve N18

This valve is activated directly by the engine control unit and electromagnetically adjusts the opening stroke for exhaust gas recirculation. The integrated exhaust gas recirculation potentiometer signals the actual opening stroke of the valve to the engine control unit.



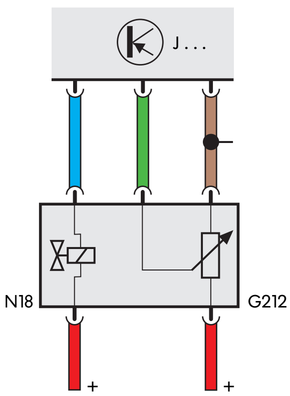
231_043

1 Engine control unit J...
2 Exhaust gas recirculation valve N18 and exhaust gas recirculation potentiometer G212
3 Vent
4 Catalyst



The EGR valve and the exhaust gas recirculation valve are combined in the electrical exhaust gas recirculation system.

● Electrical circuit



231_056

● Effects of failure of valve

If the valve fails in the open position, the engine shuts down at idling speed and can no longer be started.
If the valve remains closed, the failure has no effects on vehicle operation.
The fault will nevertheless be detected and saved.

Electric throttle drive

The throttle valve was previously adjusted mechanically by means of a Bowden cable. The throttle valve was only actuated by electric motor when the engine was running at idling speed or when a cruise control system was in use. Use of the electrical throttle control enables the engine control unit to adapt the throttle valve position to the given basic conditions in any driving situation.

● Function

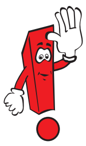
The driver's preference or the signals from the accelerator pedal module are transferred to the engine control unit. Making allowance for all auxiliarysignals, the engine control unit then determines how the torque requirement can best be implemented.

For example, auxiliary signals are supplied by:

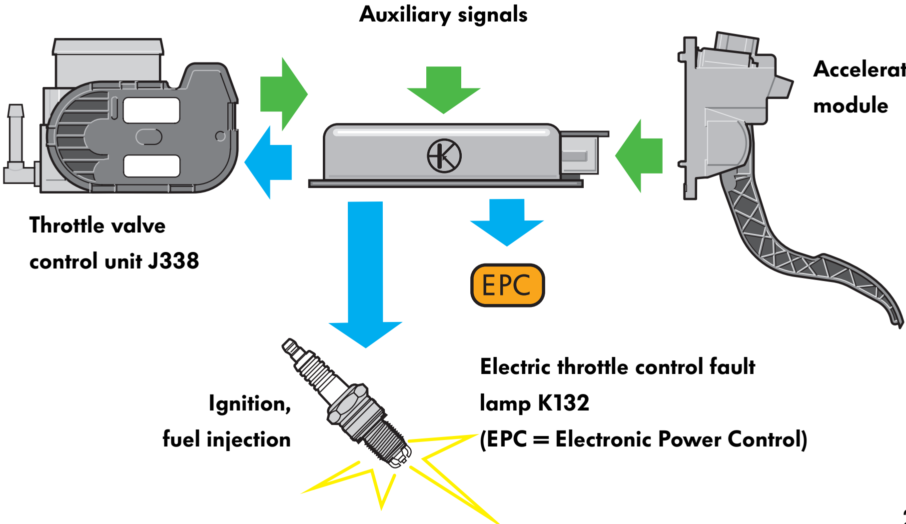
- The cruise control system,
- The air conditioning system,
- The idle speed control,
- The lambda control,
- The automatic transmission and
- ABS/ESP.

The torque requirement is implemented via the electromotively adjustable throttle valve, the ignition system and the fuel injection system.

Malfunctions are indicated via the electric throttle control fault lamp.



For detailed information regarding the electric throttle drive, please refer to Self-Study Programme 210.

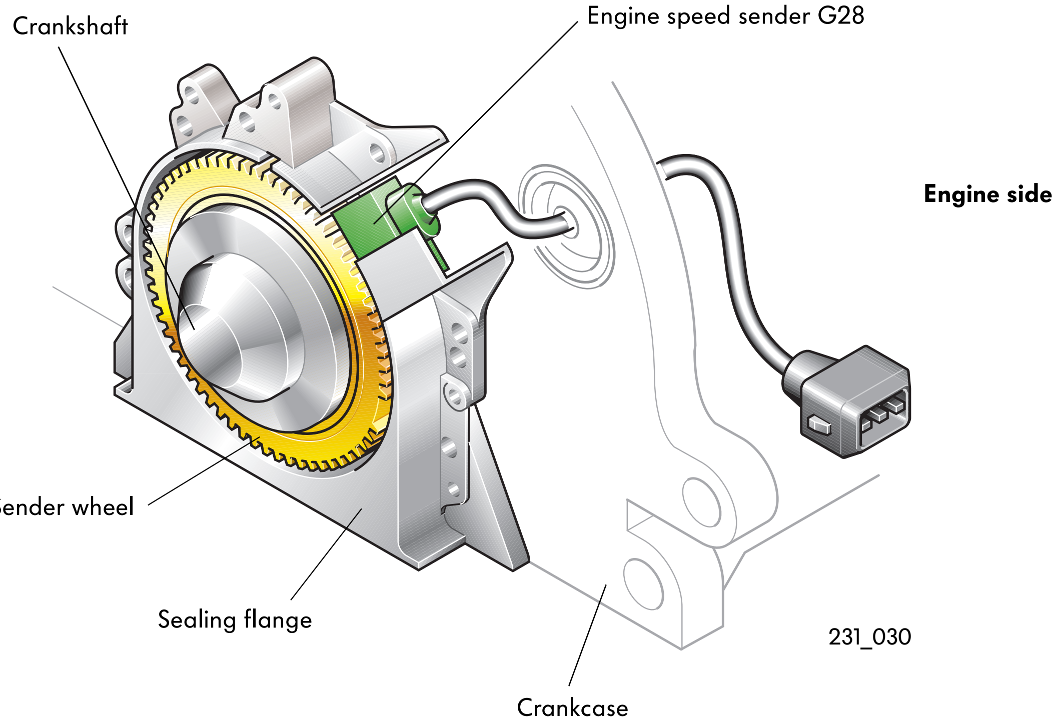


231_008

Integrated shaft sealing ring sensor

In several engines, a new Generation of engine speed sender G28 is in use – the “Integrated shaft sealing ring sensor” (IWDS – Integrierter Wellendichtring-Sensor).

The sender is mounted in a sealing flange for the crankshaft on the gearbox side of the engine.
The sender wheel (60-2 teeth) is press-fitted on the crankshaft in a precisely defined position.
The IWDS systems are made by two different manufacturers and, therefore, may differ in terms of their design.



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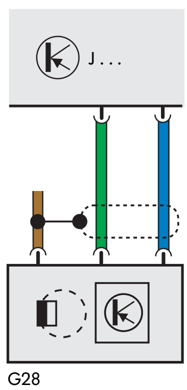
- Electrical circuit



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- Effects of failure

Maximum engine speed is reduced and the engine control unit calculates a default value for engine speed from the signal supplied by Hall sender G40.

The description and explanation of EOBD is more detailed than the descriptions of individual components or systems. The difficulties involved quickly become apparent when one considers that EOBD is not an integrated vehicle system; many individual systems and components are continosly checked for correct functioning. The various vehicle types, engines, engine control units, etc., also have to be taken into account.

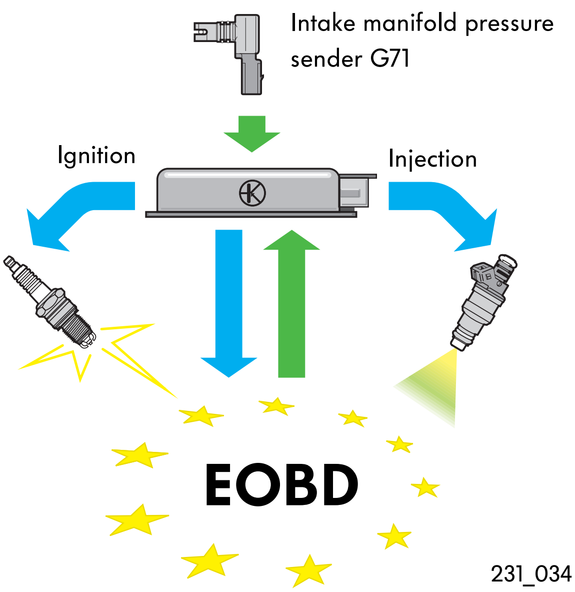
To simplify matters, we will provide you with an overview of the various types of engine control unit and engine control units before explaining the test procedures.

Basic types of engine control unit

Basically, engine management systems are classified according to how operating states in the intake manifold (air mass or intake manifold pressure) are determined. This classification is not referred to specific engine control unit manufacturers, because they usually supply both types.

The intake air quantity or intake manifold pressure are required to calculate

- The ignition point
- The injection quantity
- And for EOBD monitoring of almost all components.



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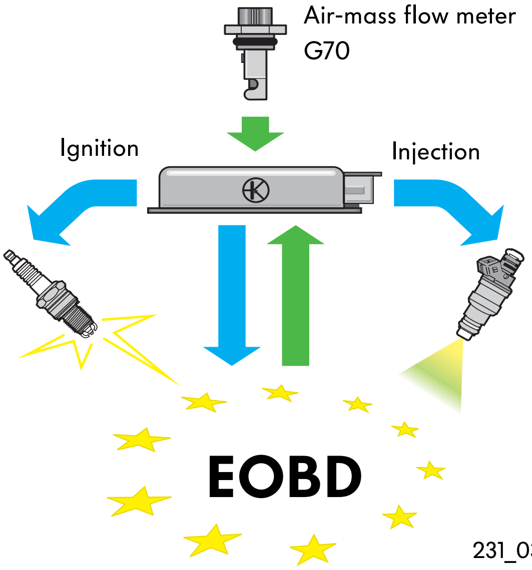
Intake manifold pressure systems

In these engine management systems, intake air quantity is determined with the aid of the intake manifold pressure sender.
These systems do not have an air-mass flow meter.

EOBD variants

Air mass systems

As the name suggests, the task of the air-mass flow meter is to determine the intake air quantity. The intake manifold pressure sender is no longer required for this purpose.



231_035

Turbocharged engines have air-mass flow meters **and** intake manifold pressure senders because the intake manifold pressure sender is also required to measure the charge pressure.

Engine control units and air flow metering

The various engine control units will now be assigned to the types of engine control unit (air flow metering in intake manifold).

Engine control units	Air flow metering
Bosch Motronic ME 7.5.10	Intake manifold pressure
Bosch Motronic ME 7.1	Air mass
Bosch Motronic ME 7.5	Air mass
Bosch Motronic ME 5.9.2	Air mass
Magneti Marelli 4LV	Intake manifold pressure
Siemens Simos 3	Air mass

Engine control units and diagnostics

In the following table, the individual EOBD diagnostic routines are assigned to the engine control units. It can be seen that not all engine control units use the same diagnostic routines within the EOBD.

	Engine control units		
Diagnostic routines	Siemens Simos 3	Magneti Marelli 4LV	Bosch Motronic M 5.9.2
Comprehensive Components Monitoring	✓	✓	✓
Voltage curve shift and adaption of probe before catalyst	✓	✓	✓
Lamdba probe heater diagnosis	✓	✓	✓
Reaction time diagnosis of probe before catalyst	✓	✓	✓
Control limit diagnosis of probe after catalyst	✓	✓	✓
Motion diagnosis of probe after catalyst	✓	✓	✓
Catalytic conversion diagnosis	✓	✓	✓
Fuel tank purging system Flow rate diagnosis	✓		✓
Fuel tank purging system Modulation diagnosis		✓	
Misfiring Irregular running method	✓		✓
Misfiring Moment analysis method		✓	
Exhaust gas recirculation Pressure diagnosis		✓	
Electric throttle drive	✓	✓	
CAN databus Data diagnosis	✓	✓	✓
Secondary air Flow rate diagnosis	✓		✓
Charge pressure limit diagnosis			

EOBD variants

Engine control units

Diagnostic routines	Bosch Motronic ME 7.1	Bosch Motronic ME 7.5	Bosch Motronic ME 7.5.10
Comprehensive Components Monitoring	✓	✓	✓
Voltage curve shift and adaption of probe before catalyst	✓	✓	✓
Lamdba probe heater diagnosis	✓	✓	✓
Reaction time diagnosis of probe before catalyst	✓	✓	✓
Control limit diagnosis of probe after catalyst	✓	✓	✓
Motion diagnosis of probe after catalyst	✓	✓	✓
Catalytic conversion diagnosis	✓	✓	✓
Fuel tank purging system Flow rate diagnosis	✓	✓	✓
Fuel tank purging system Modulation diagnosis			
Misfiring Irregular running method	✓	✓	✓
Misfiring Moment analysis method			
Exhaust gas recirculation Pressure diagnosis			✓
Electric throttle drive	✓	✓	✓
CAN databus Data diagnosis	✓	✓	✓
Secondary air Flow rate diagnosis	✓	✓	
Charge pressure limit diagnosis		✓	

Many of the diagnostic routines were previously explained and described in Self-Study Programme 175. To avoid repetition, new diagnostic routines will be dealt with in detail and known routines will be mentioned only. Known routines are indicated by a red "icon" and the text "SSP 175".

SSP 175

Comprehensive Components Monitoring

(Line-conducted faults)

This diagnostic routine monitors the functioning of all sensors, actuators and output stages that are relevant to exhaust emissions within the framework of the EOBD.
For details of the individual components, refer to the function diagrams.

SSP 175

Components are tested according to the following criteria:

- Check of input and output signals (plausibility)
- Short circuit to earth
- Short circuit to positive
- Open circuit

Lambda probe

Voltage curve shift diagnosis and adaption of the probe before the catalyst

Ageing or poisoning can cause a shift in the voltage curve of the probe before the catalyst. This shift is detected by the engine control unit and can be compensated (adapted) within defined bounds.The diagnosis sequence is basically the same despite the new broadband lambda probe.

SSP 175

Lamdba probe heater diagnosis

By measuring the probe heating resistance, the engine control unit checks the heat output of the lamdba probe heater for correctness.

SSP 175

Diagnostic routine

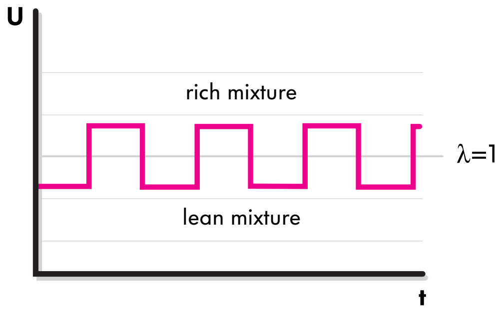
Reaction time diagnosis of probe before catalyst

The reaction time of the probe before the catalyst can also deteriorate due to ageing or poisoning.

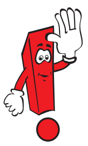
The procedure for diagnosis of these faults was previously explained in Self-Study Programme 175. However, the signals from the probe before the catalyst have changed due to the use of broadband lambda probes. Hence, the description of this diagnosis routine with the current signals from probe before the catalyst.

Modulation of the fuel/air mixture by the engine control unit is prerequisite for reaction time diagnosis. This modulation takes the form of slight fluctuation between lean and rich mixture. It is induced artificially by the engine control unit, because the lambda value can be controlled by using the broadband lambda probe to such as high degree of accuracy that it is possible to maintain a constant value of $\lambda=1$. For optimal operation, however, the catalyst requires the mixture composition to fluctuate slightly. Therefore, the engine control unit modulates this mixture when a broadband lambda probe is being used.

Mixture modulation of the engine control unit

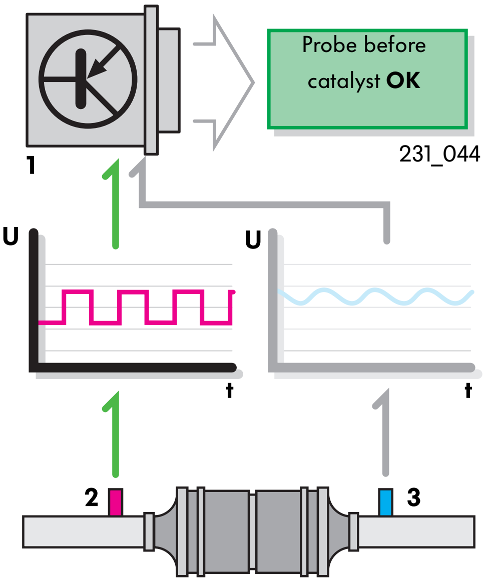


U = voltage, t = time 231_048



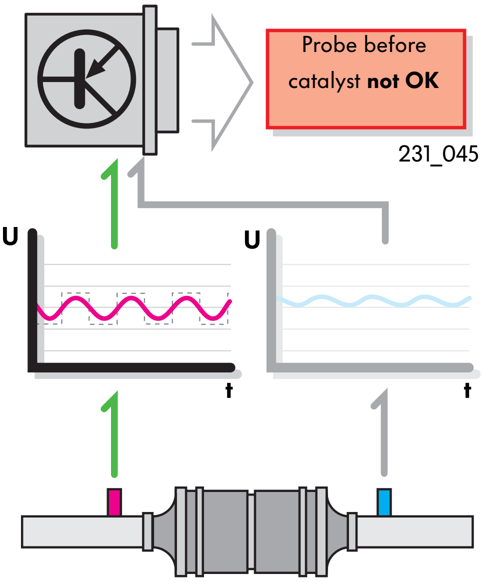
The signal from the broadband lambda probe is specified here as voltage U, because the Vehicle Diagnostic, Testing and Information System VAS 5051 converts the actual output signal (current intensity I) into a voltage and displays this value.

- The signal from the probe before the catalyst follows modulation of the fuel/air mixture by the engine control unit.



U = voltage, t = time

- The signal from the probe before the catalyst can no longer follow modulation of the fuel/air mixture.



1 Engine control unit
2 Probe before catalyst
3 Probe after catalyst

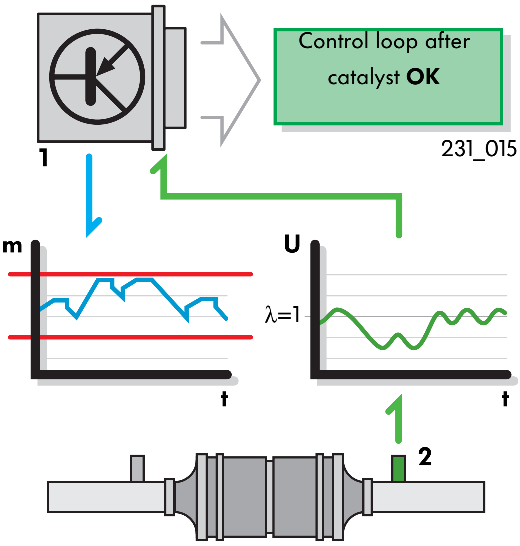
Diagnostic routines

Control limit diagnosis of probe after catalyst

When the fuel/air mixture is of optimal composition, the voltage of the probe after the catalyst will be in the region of λ=1. If the probe after the catalyst produces a higher or lower average voltage, this indicates that the fuel/air mixture is too rich or too lean. The engine control unit therefore changes its lambda control value (this affects the fuel/air-mixture composition) until the probe after the catalyst again signals λ=1. This lambda control value has defined control limits. If these control limits are exceeded, EOBD assumes that there is a fault in the probe after the catalyst or in the exhaust system (secondary air).

- Lean fuel/air mixture and correct control

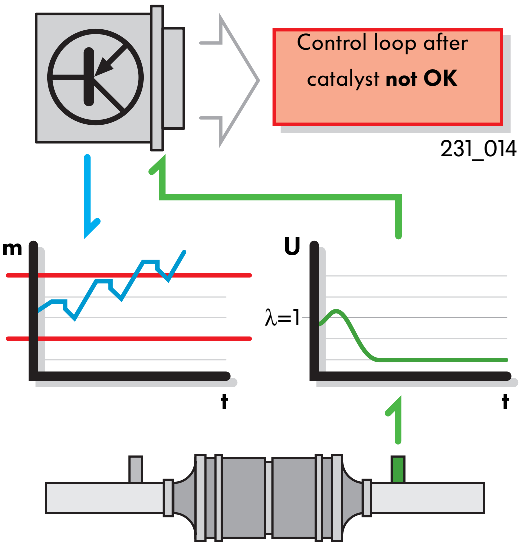
  The probe after the catalyst signals a rise in oxygen concentration in the exhaust gas to the engine control unit through a voltage reduction. The engine control unit then increases the lambda control value, and the fuel/air mixture is enriched. The voltage of the probe after the catalyst rises and the engine control unit is again able to reduce the lambda control value. This control loop extends over a lengthy vehicle operating period.



m = lambda control value, U = voltage, t = time

- Lean fuel/air mixture and reaching of control limit value

  In this case, too, the probe after the catalyst signals a rise in oxygen concentration in the exhaust gas to the engine control unit through a voltage reduction. The engine control unit then increases the lambda control value, and the fuel/air mixture is enriched. Despite this enrichment of the fuel/air mixture, the probe voltage remains low (due to the fault) and the engine control unit continues to increase the lambda control value until the control limit is reached and the fault is detected.

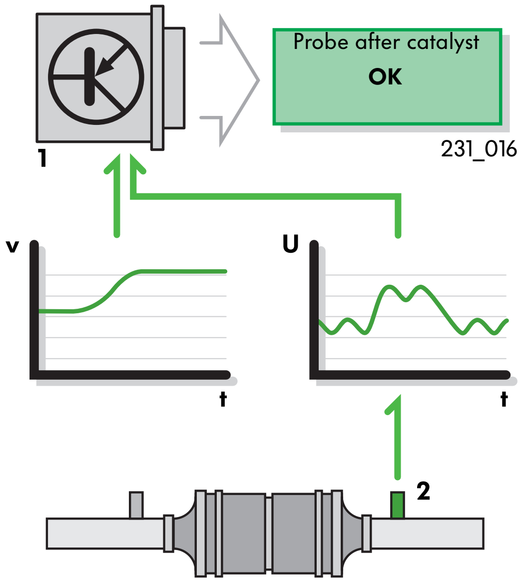


1 Engine control unit
2 Probe after catalyst

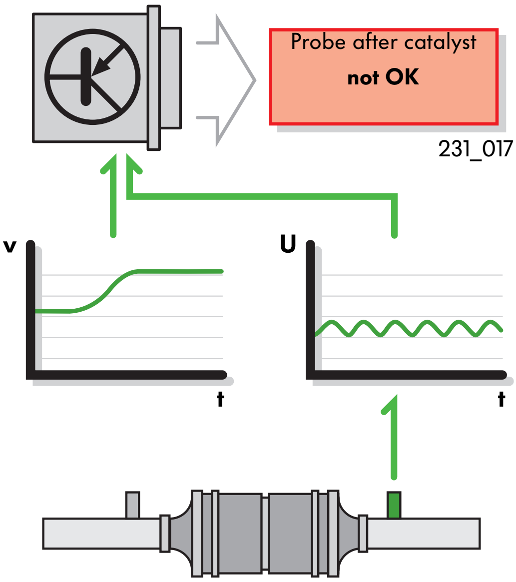
Motion diagnosis of probe after catalyst

The operating performance of the probe after the catalyst is monitored also. To this end, the engine control unit checks the signals from the probe in acceleration and overrun modes.
When the vehicle is accelerating, the fuel/air mixture is rich, the oxygen concentration in the exhaust gas decreases and the probe voltage must rise. In overrun mode, the exact opposite applies: fuel feed is off, the oxygen concentration in the exhaust gas increases and the probe voltage must drop. If the probe after the catalyst does not react as expected, the engine control unit assumes that the probe after the catalyst is defective.

- Example: vehicle acceleration



231_016



231_017

v = vehicle road speed, U = voltage,
t = time

1 Engine control unit
2 Probe after catalyst

Catalyst

Catalytic conversion diagnosis

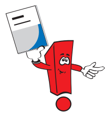
The engine control unit compares the voltages of the probes before and after the catalyst. In this way, the degree of efficiency - and hence the performance - of the catalyst can be determined.

SSP 175

Fuel tank purging system

Flow rate diagnosis

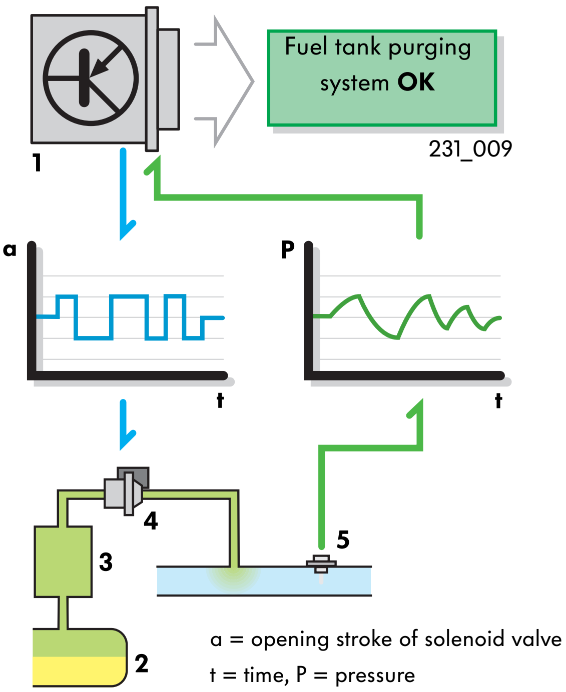
When the fuel tank purging system is activated, the fuel/air mixture changes. If the activated charcoal canister is full, the mixture will be rich. If the activated charcoal canister is empty, the mixture will be lean. This change of mixture composition is registered by the probe before the catalyst and serves as confirmation that the fuel tank purging system is functioning properly.

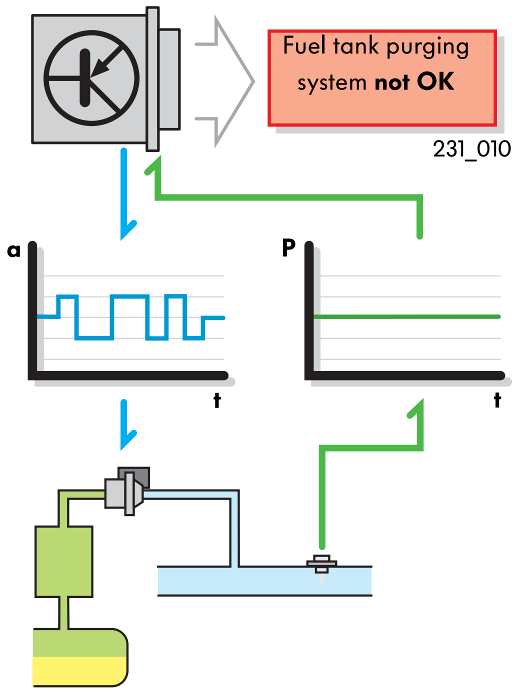


SSP 175

Modulation diagnosis

This diagnosis routine carries out checks cyclically. The engine control unit opens and closes activated charcoal filter system solenoid valve 1 slightly at defined intervals. The intake manifold pressure sender records the intake manifold pressure "modulated" in this way and sends this pressure value to the engine control unit where it is correlated and evaluated.





1 Engine control unit
2 Tank
3 Activated charcoal canister
4 Activated charcoal filter system solenoid valve N80
5 Intake manifold pressure sender G71

Cylinder-selective misfiring detection system

Irregular running method

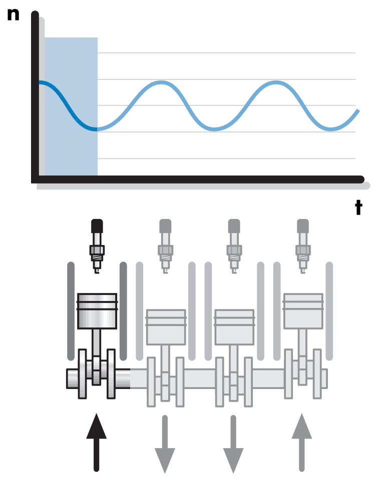
The engine speed sender can recognise irregularities in engine speed caused by misfiring with the aid of the crank disk.
In combination with the signal from the Hall sender (camshaft position), the engine control unit can locate the cylinder in question, save the fault to fault memory and activate self diagnosis fault warning lamp K83.

SSP 175

Moment analysis method

As with the irregular running method, the moment analysis method recognises cylinder-selective misfiring from the signal supplied by the engine speed sender and the Hall sender. The difference between these two methods lies in the way the engine speed signal is evaluated. The moment analysis method correlates the irregular engine speed caused by ignition and compression with fixed calculations in the engine control unit. The basis for these calculations is the engine load and engine speed dependent torque, the centrifugal mass and the resulting engine speed characteristic.
The fluctuation in engine moment calculated in this way is equally as conclusive as the results of the irregular running method, but the engine speed characteristic is required to be analysed for each engine and stored in the engine control unit.

Compression ratio in cylinder 1



231_018

n = engine speed, t = time

- Irregular engine speed

  For the sake of simplicity, only the 1st cylinder will be examined in this example.

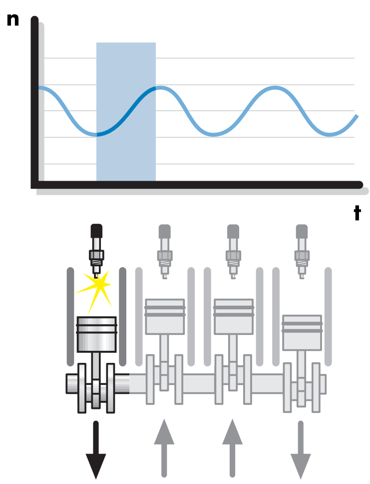
  During the compression cycle, the kinetic energy of the engine is used to compress the fuel/air mixture. Engine speed decreases.

Diagnostic routine

The compression cycle is followed by the ignition cycle, and engine speed is increased. In this way, engine speed is made to fluctuate by compression and ignition during each combustion cycle.

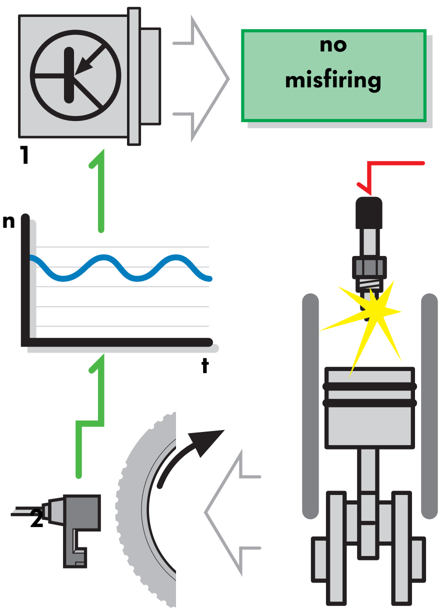
When all four cylinders are examined, the individual engine speed fluctuations are superposed to produce a resulting curve. This curve is measured by the engine speed sender and checked by the engine control unit against a calculation made with characteristic engine data.

Ignition in 1st cylinder

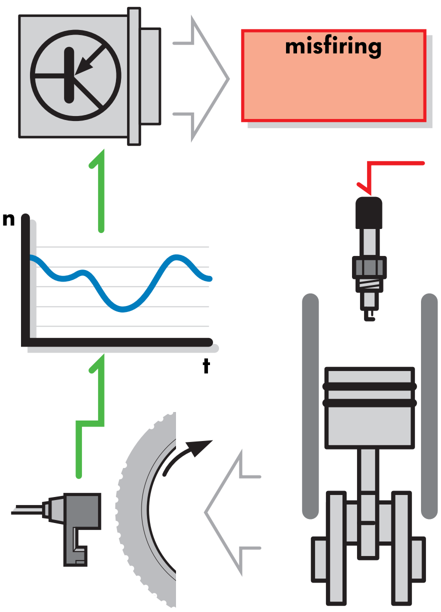


231_019

- Misfiring detection using the engine speed signal



231_020



231_021

n = engine speed, t = time

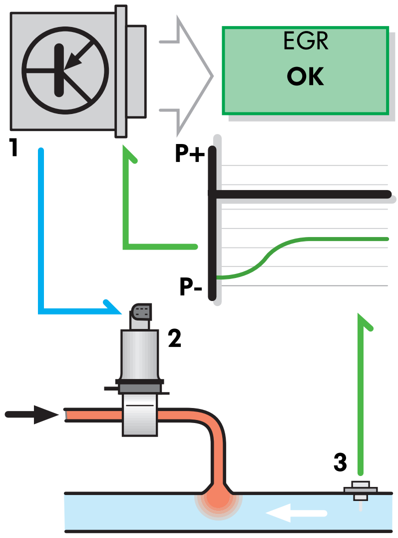
1 Engine control unit
2 Engine speed sender G28

If the EOBD exhaust emission limits are exceeded due to misfiring, then the self diagnosis fault warning lamp will be lit continuously.
If, however, there is a risk of misfiring causing damage to the catalyst and the engine is running within the critical load RPM range, the self diagnosis fault warning lamp initially flashes and a short time later the fuel feed to the corresponding cylinders is shut off.

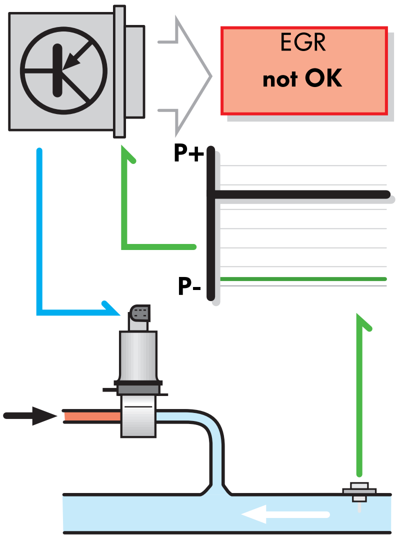
Electrical exhaust gas recirculation

Pressure diagnosis

While exhaust gas is admitted into the intake manifold, the intake manifold pressure sender must register a rise in pressure (less partial pressure). The engine control unit compares the pressure rise in the intake manifold with the supplied exhaust gas quantity and can thus determine whether the exhaust gas recirculation (EGR) system is functioning properly. This diagnosis is only carried out in overrun mode, because injection is deactivated as a disturbing influence for measurement and the intake capacity of the engine is very high.



231_022



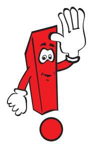
231_023

1 Engine control unit
2 EGR valve N18
3 Intake manifold pressure sender G71

P+ = excess pressure, P- = vacuum, t = time

Electric throttle drive

The EOBD uses the electrical throttle control diagnostic functions which indicate a fault via the electric throttle control fault lamp.
If these faults still exist during the next one or two driving cycles, the EOBD also activates the exhaust gas warning lamp.



For more detailed information relating to the diagnostic functions of the electrical throttle control, please refer to Self-Study Programme 210.

The electric throttle drive checks:
- the function processor in the engine control unit
- the accelerator position sender
- the angle senders for throttle valve drive
- the brake light switch
- the brake and clutch pedal switch
- the vehicle road speed signal

Diagnostic routines

CAN databus

Data diagnosis

Each engine control unit knows the electronic components which exchange information via the CAN databus in the vehicle. If the minimum number of messages is not received from a component, a fault is detected and saved.

Further components which the CAN databus uses include:

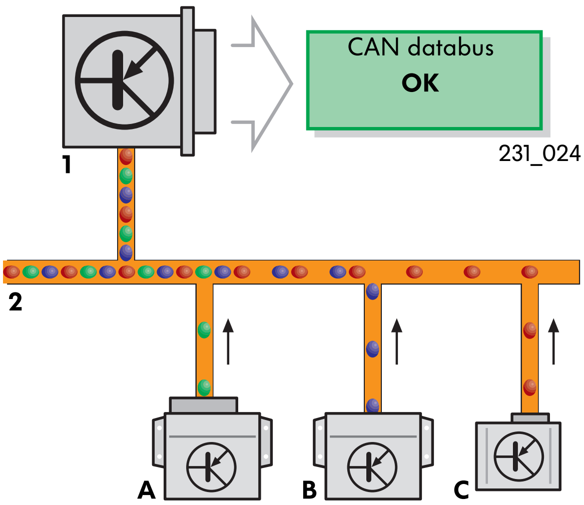
- Control unit with display unit in the dash panel insert
- ABS control unit/ESP
- Automatic gearbox control unit

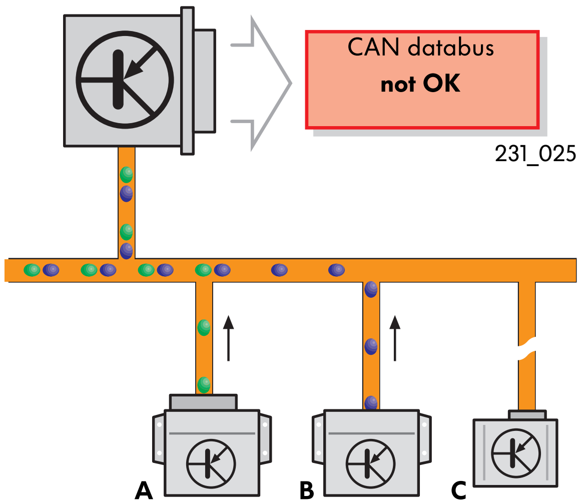
- CAN databus in proper service condition

  All connected components (in this case: control units) regularly transmit messages to the engine control unit.
  The engine control unit recognises that no messages are missing and data is being exchanged properly.

- CAN databus interrupted

  A component cannot transmit information to the engine control unit. The engine control unit notices the missing information, identifies the component affected and saves a corresponding fault message to fault memory.





1 Engine control unit
2 CAN databus

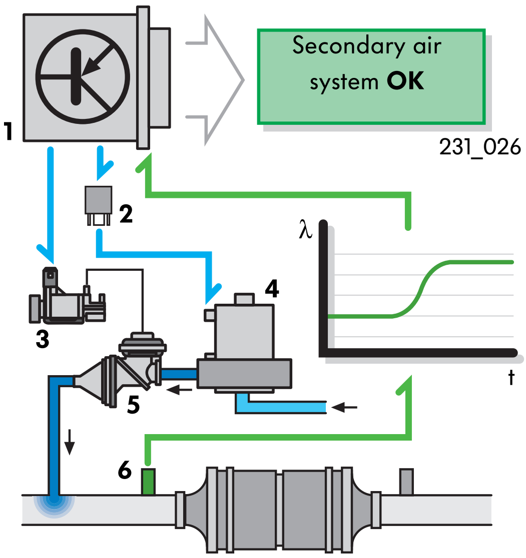
A-C Various control units on board the vehicle

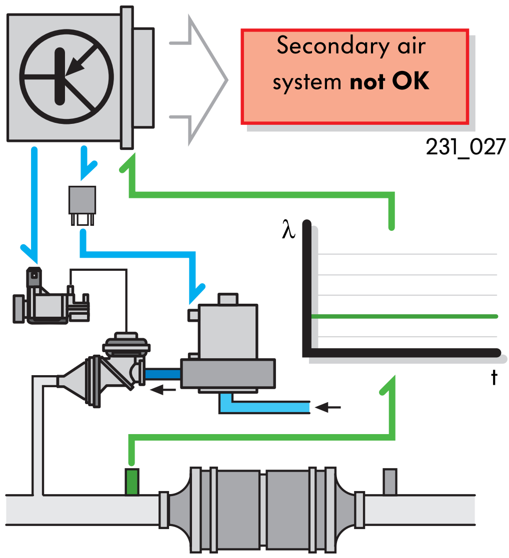
Secondary air system

The performance of the secondary air system was previously tested via the lambda control value.
This means that the voltage present at the probe before the catalyst must indicate a lean mixture during secondary air discharge ($\lambda > 1$) although the engine control unit is running the engine on a rich mixture.

Flow rate diagnosis

Since the introduction of the broadband lambda probe, the signal from the probe before the catalyst is used for diagnosis purposes, because the broadband lambda probe supplies more detailed measurement results than the step type lambda probe for example. The actual air mass flow is calculated and checked on the basis of the lambda differential (lambda value before and during secondary air discharge).





λ = lambda, t = time

1 Engine control unit
2 Secondary air pump relay J299
3 Secondary air inlet valve N112
4 Secondary air pump V101
5 Combi valve
6 Probe before catalyst

Diagnostic routine

Charge pressure control

Charge pressure limits diagnosis

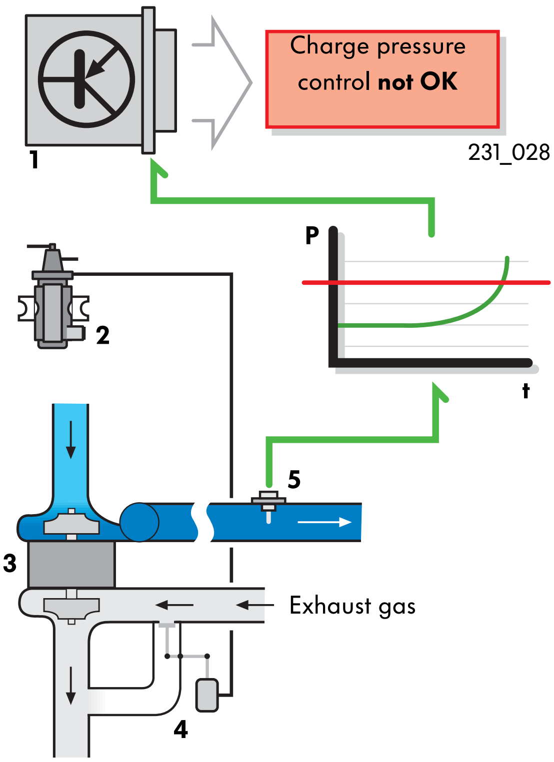
In turbocharged engines, charge pressure is checked for exceeding the maximum permissible value within the framework of the EOBD. The check also serves to protect the engine, which must not be overloaded by excessively high charge pressure.

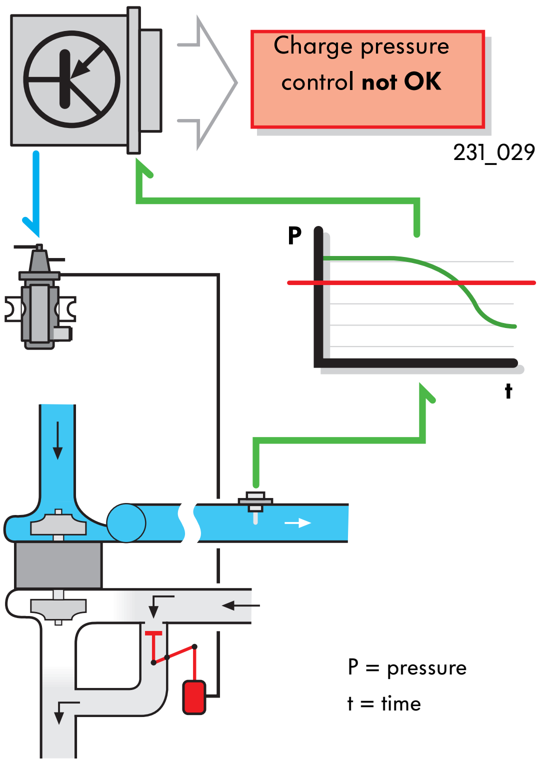
- The charge pressure limit is exceeded

  The maximum permissible charge pressure is exceeded due to a fault in the charge pressure control. The intake manifold pressure sender signals the presence of charge pressure to the engine control unit, and the engine control unit detects the fault.

- The protective function is initiated

  In this case, it is not enough to indicate and save the fault. The exhaust gas turbocharger has to be deactivated in order to avoid damaging the engine. For this purpose, the "waste gate" of the turbocharger is opened and the driving exhaust gases are diverted through it.





1 Engine control unit
2 Solenoid valve for charge pressure control N75
3 Exhaust gas turbocharger with charge pressure control valve
4 Waste gate
5 Intake manifold pressure sender G71

Notes

Self diagnosis

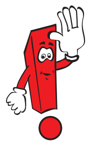
Readiness code

All electrical components are continuously checked for proper functioning within the framework of the EOBD. In addition, integrated systems (e.g. exhaust gas recirculation system) are checked by non-continuous diagnostic routines.
The readiness code is set to check whether these diagnoses were performed or not.
The readiness code consists of an 8-character number code; a 0 (diagnosis performed) or a 1 (diagnosis not performed) can be assigned to each digit position.

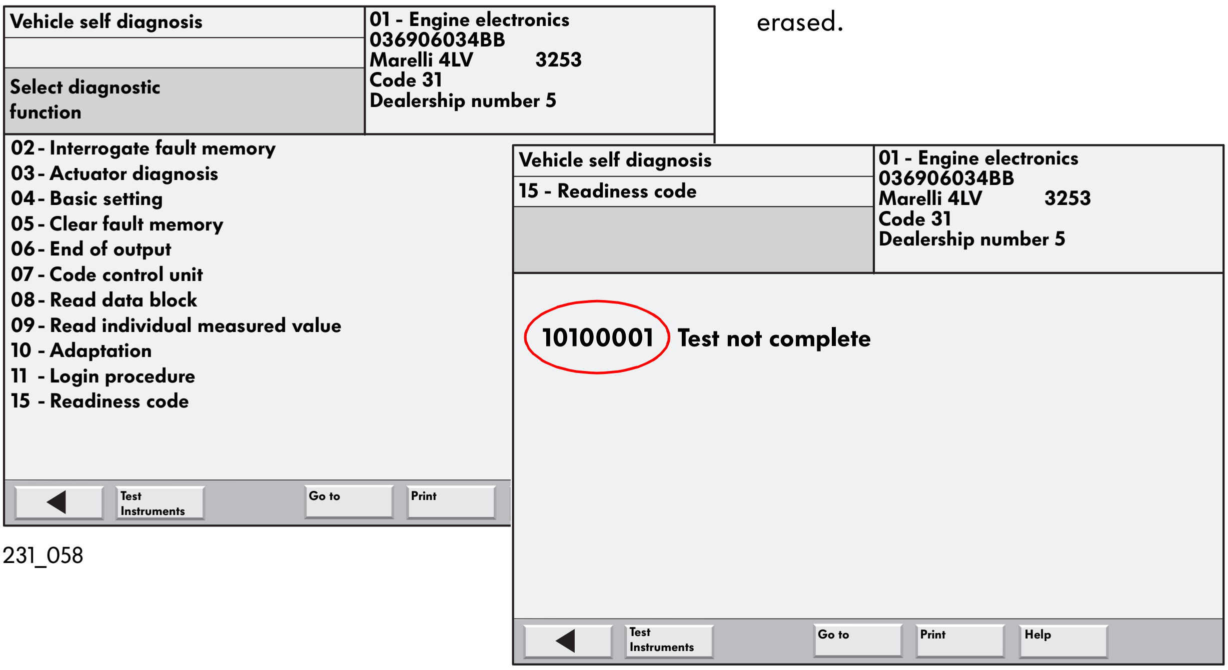
The engine control unit sets the readiness code when:

- the readiness code is cancelled
- the engine control unit is put into operation for the first time.

The readiness code does not check for faults occurred; it indicates only whether diagnoses were performed.
If the diagnoses produce no erroneous entries, the systems are in proper service condition.



Care should be taken to ensure that the fault memory is not erased unnecessarily, because this also causes the readiness code to be reset or erased.



231_058

The readiness code marked above represents the performance status of the following systems in the given order:

1. Catalyst
2. Catalyst heating
3. Fuel tank purging system
4. Secondary air system
5. Air conditioning system
6. Lambda probe
7. Lamdba probe heater
8. Exhaust gas recirculation

Unused digit positions of the readiness code are generally set to "0", because not all diagnoses are available in all vehicles.

Read out readiness code

There are two possible ways to read out the readiness code.

- Using any Generic Scan Tool (OBD visual display unit) or
- Using the Vehicle Diagnostic, Testing and Information System VAS 5051.

The procedures are explained on the following pages.

Generate readiness code

The readiness code can only be generated by running the diagnoses.
There are three possible ways to do this:

- Perform an NEFZ ("Neuer Europäischer Fahrzyklus" = new European driving cycle).
  However, the standard workshop will be unable to perform the NEFZ on a roller dynamometer upon completion of repair work.
- Run the vehicle in average operating mode for long enough
  (this may necessitate several trips).
- Using the VAS 5051 diagnostic system, perform a defined test routine (short trip) for each relevant vehicle system.
  The procedure is also explained in "Vehicle Diagnostic, Testing and Information System VAS 5051".

Generic Scan Tool (OBD visual display unit)

It must be possible to read out emission-related faults and data acquired by the engine control unit within the framework of the EOBD using any OBD visual display unit. Therefore, the detected faults are saved using an SAE code. This SAE code is used by all OBD systems.

SAE code:
- **P0**xxx: Codes with set fault texts defined by the SAE (Society of Automotive Engineers)
  (same for all automobile manufacturers)
- **P1**xxx: Codes defined by automobile manufacturers which are required to be reported to the government (these codes are defined differently for different automobile manufacturers)

Self diagnosis

An OBD visual display unit can be put into operation simply by connecting it to the diagnosis interface in the passenger cabin. Communications between the engine control unit and OBD visual display unit will be established automatically.

For fault tables for the SAE codes, refer to the Workshop Manual of the relevant engine control unit.

re. Mode 3 and 7:
For fault acknowledgement, several diagnosis routines require one or more trips until the self diagnosis fault warning lamp is activated.

An OBD visual display unit facilitates the following functions:

- Mode 1:
  Read out current engine operating data (actual data, readiness code).

- Mode 2:
  Read out operating conditions which existed while saving a fault
  (only used if a fault has occurred).

- Mode 3:
  Read out emission-related faults which have caused the self diagnosis fault warning lamp to be activated.

- Mode 4:
  Erase fault code, readiness code and operating conditions (Mode 2).

- Mode 5:
  Display lambda probe signals.

- Mode 6:
  Display measured values of non-permanently monitored systems (e.g. secondary air system, fuel tank purging system, exhaust gas recirculation).

- Mode 7:
  Read out faults which have still not activated the
  self diagnosis fault warning lamp.

- Mode 8:
  This mode is not used in Europe.

- Mode 9:
  Display vehicle information
  (e.g. ID No., engine code, engine control unit type, software identification, software checksum).

Vehicle Diagnostic, Testing and Information System VAS 5051

Using VAS 5051, you can read out the readiness code and perform the individual short trips for the vehicle systems required to generate the readiness code.

Over and above the functions of the OBD visual display unit, VAS 5051 provides additional adjustment, diagnosis and fault finding functions. The fault-finding procedure can be optimised by accessing all key engine data.

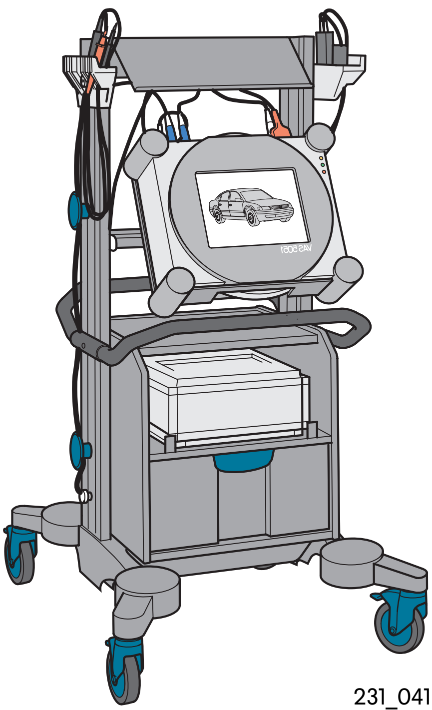
Read out readiness code

1st possibility:

- Turn on the ignition.
- Activate "Vehicle self diagnosis" mode.
- Select the engine control unit with address word "01".
- Select function "15 - Readiness code".

2nd possibility (Generic Scan Tool-Mode)

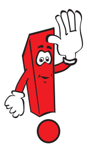
- Turn on the ignition.
- Activate "Vehicle self diagnosis" mode .
- Select Generic Scan Tool Mode with address word "33".
- Select Mode 1 "Read out actual engine operating data".



231_041

Perform short trips

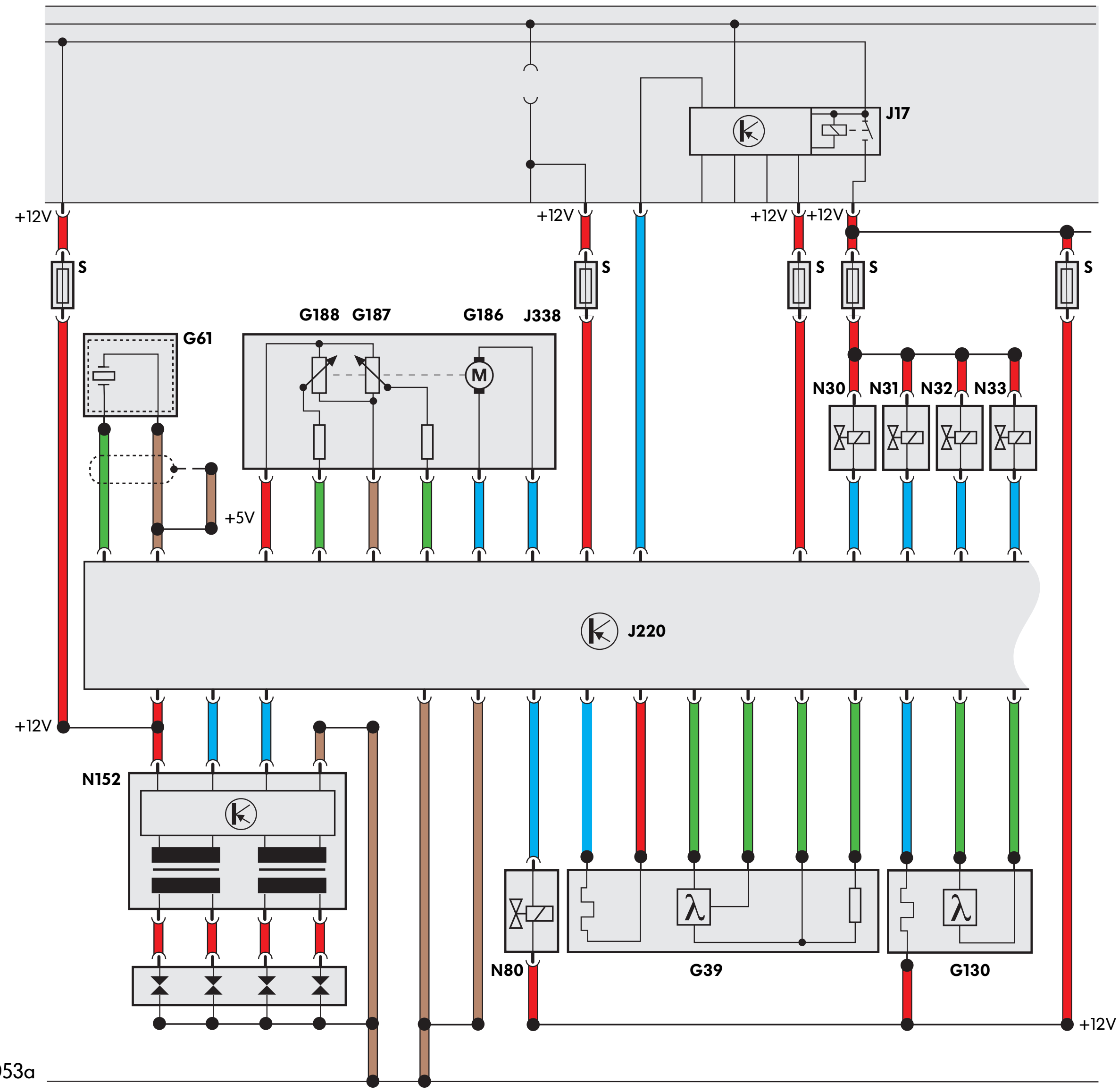
Use function "04 – Initiate basic setting to invoke the individual short trips.
Different procedures apply to the various engine control unit variants.



For details of the steps and preconditions for performing the short trips of the various individual engine control unit variants, refer to the relevant Workshop Manuals.

Function diagram

Example 1: 1.4-ltr. 4V petrol engine 55 kW/Bosch Motronic ME 7.5.10

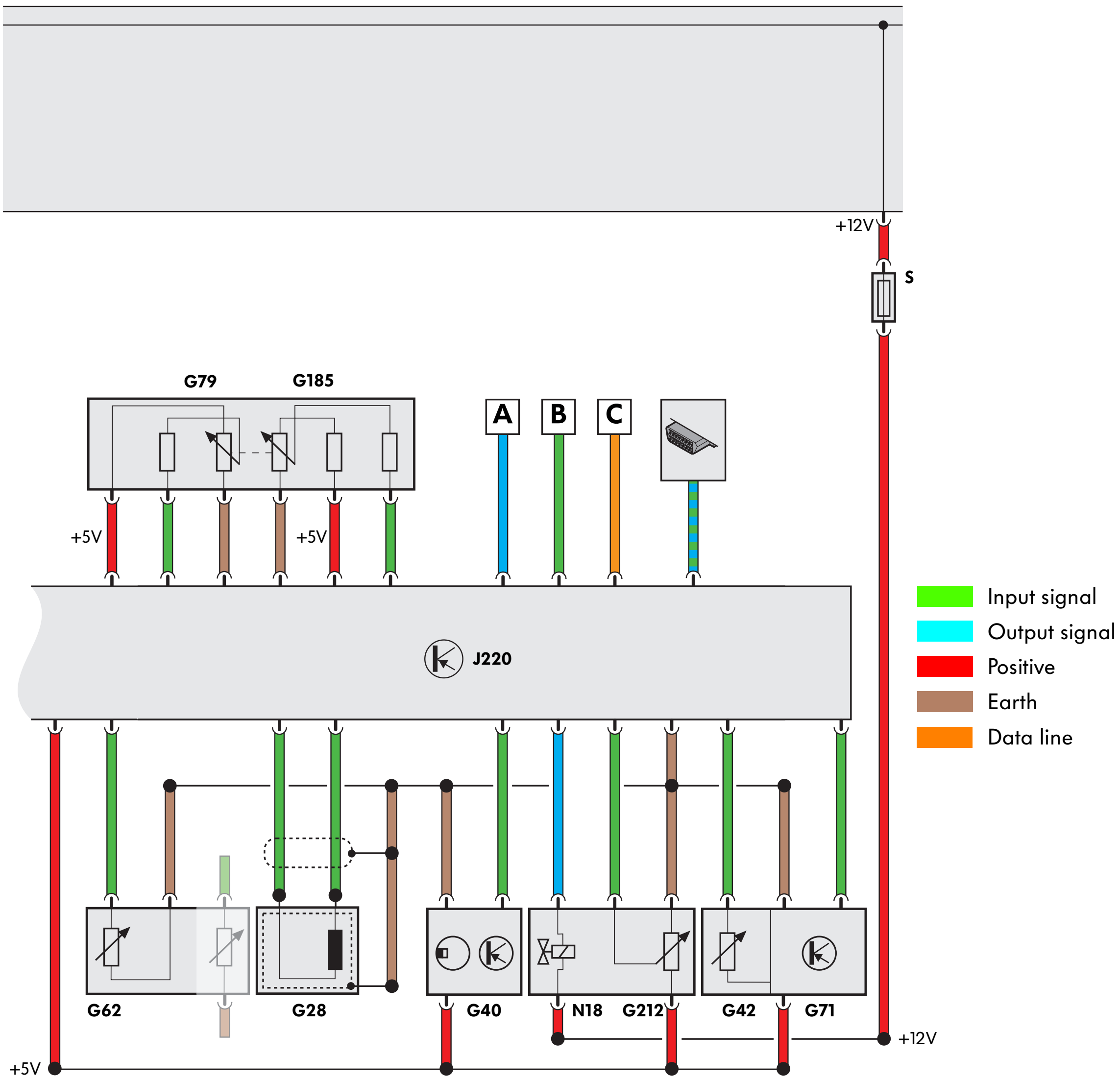


231_053a

Components

G28 Engine speed sender
G39 Lambda probe (before catalyst)
G40 Hall sender
G42 Intake air temperature sender
G61 Knock sensor I
G62 Coolant temperature sender
G71 Intake manifold pressure sender
G79 Accelerator position sender
G130 Lambda probe after catalyst
G185 Accelerator pedal position sender -2-
G186 Throttle valve drive
G187 Throttle valve drive angle sender -1-
G188 Throttle valve drive angle sender -2-
G212 Exhaust gas recirculation potentiometer

J17 Fuel pump relay
J220 Motronic control unit
J338 Throttle valve control unit

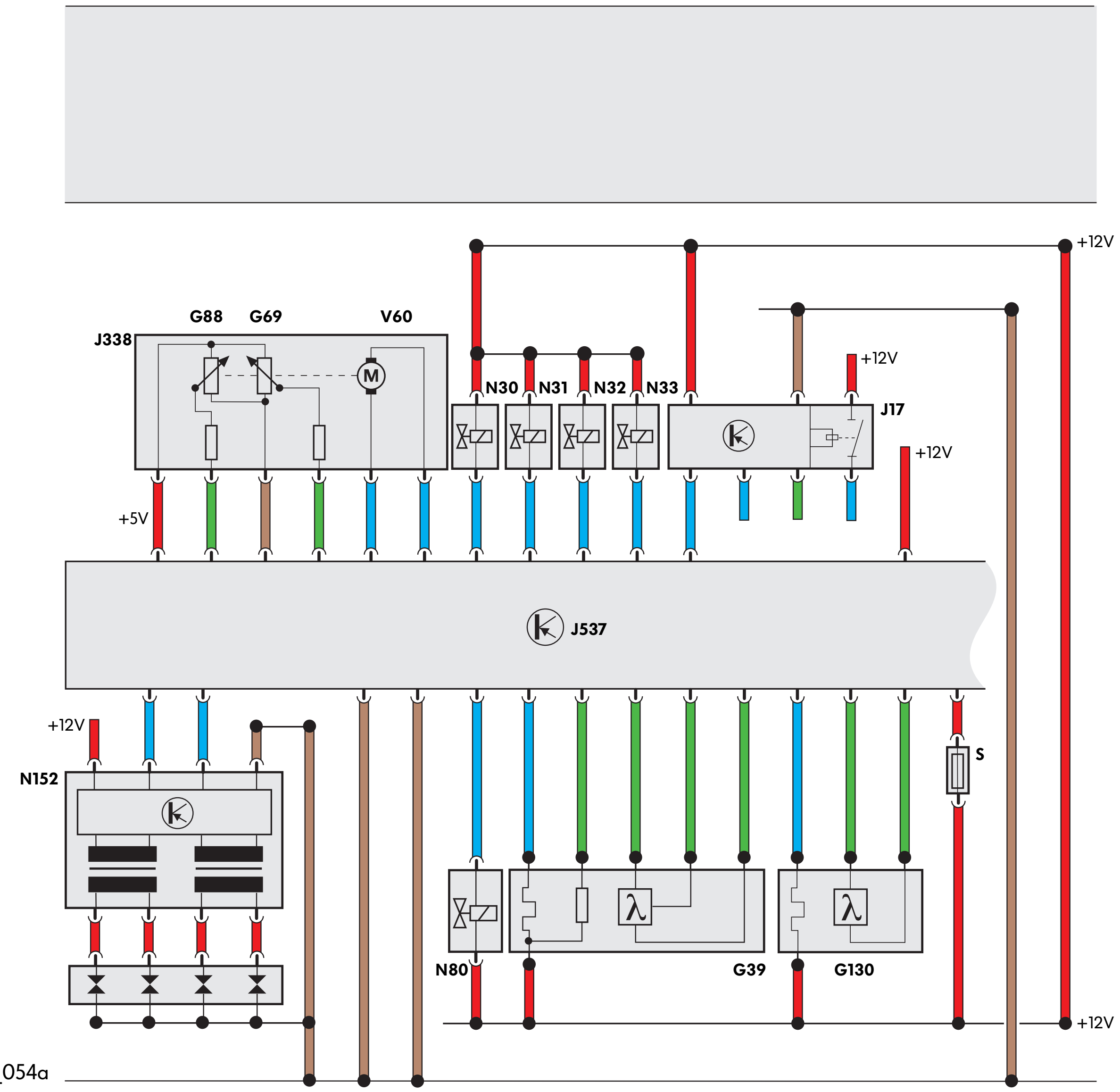


231_053b

N18	EGR valve	A	Signal to self diagnosis fault warning lamp K83 (in models dating from 2000, this signal is transferred via the CAN bus)
N30	Injector, cylinder 1	B	Road speed signal from control unit with display unit in dash panel insert J285
N31	Injector, cylinder 2	C	CAN bus
N32	Injector, cylinder 3		
N33	Injector, cylinder 4		
N80	Activated charcoal filter system solenoid valve 1		
N152	Ignition transformer		
S	Fuse		

Function diagram

Example 2: 1.4-ltr. 4V petrol engine 55 kW/Magneti Marelli 4LV



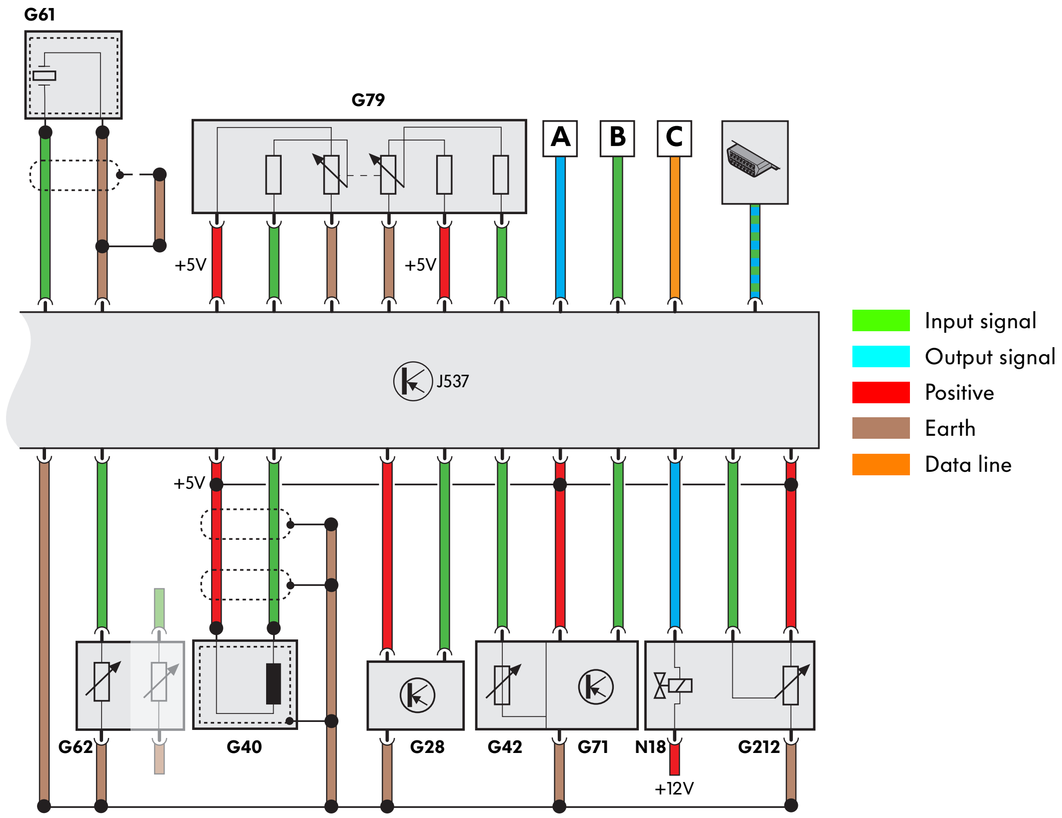
231_054a

Components

G28 Engine speed sender
G39 Lambda probe (before catalyst)
G40 Hall sender
G42 Intake air temperature sender
G61 Knock sensor I
G62 Coolant temperature sender
G69 Throttle valve potentiometer
G71 Intake manifold pressure sender
G79 Accelerator position sender

G88 Throttle valve positioner potentiometer
G130 Lambda probe after catalyst
G212 Exhaust gas recirculation potentiometer

J17 Fuel pump relay
J537 Control unit for 4LV
J338 Throttle valve control unit



231_054b

N18 EGR valve
N30 Injector, cylinder 1
N31 Injector, cylinder 2
N32 Injector, cylinder 3
N33 Injector, cylinder 4
N80 Activated charcoal filter system solenoid valve 1
N152 Ignition transformer

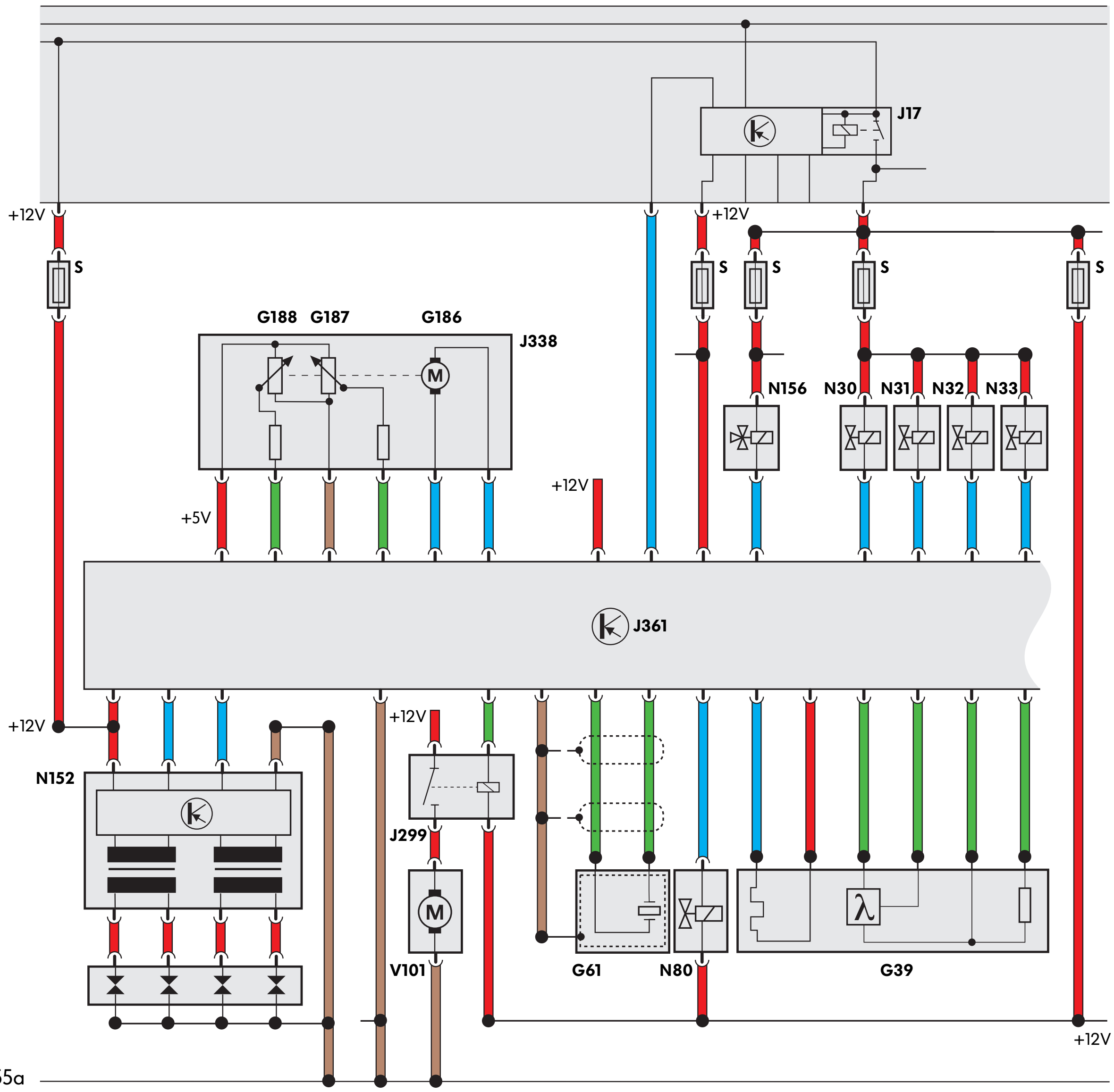
S Fuse

V60 Throttle valve positioner

A Signal to self diagnosis fault warning lamp K83 (in models dating from 2000, this signal is transferred via the CAN bus)
B Road speed signal from control unit with display unit in dash panel insert J285
C CAN bus

Function diagram

Example 3: 1.6-ltr. petrol engine 74 kW/Siemens Simos 3

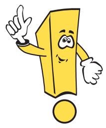


231_055a

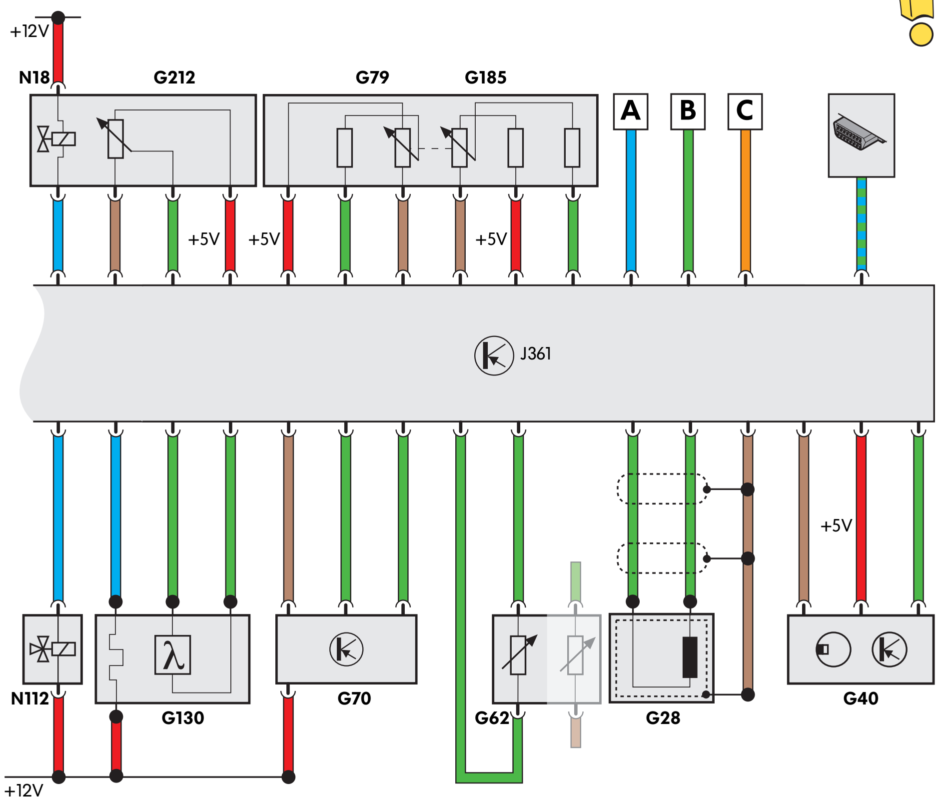
Components

G28 Engine speed sender
G39 Lambda probe (before catalyst)
G40 Hall sender
G61 Knock sensor I
G62 Coolant temperature sender
G70 Air-mass flow meter
G79 Accelerator position sender
G130 Lambda probe after catalyst
G185 Accelerator pedal position sender -2-
G186 Throttle valve drive
G187 Throttle valve drive angle sender -1-
G188 Throttle valve drive angle sender -2-
G212 Exhaust gas recirculation potentiometer

J17 Fuel pump relay
J299 Secondary air pump relay
J361 Simos control unit
J338 Throttle valve control unit



In future, lambda probes by NTK will also be fitted in combination with Simos engine control units.



- Input signal
- Output signal
- Positive
- Earth
- Data line

231_055b

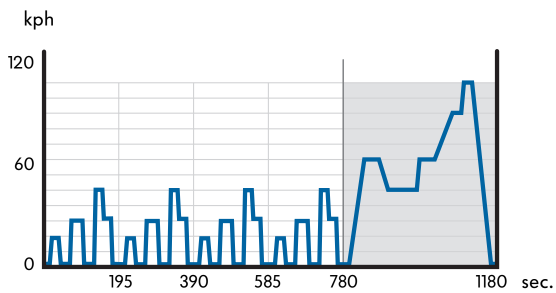
N18	EGR valve
N30	Injector, cylinder 1
N31	Injector, cylinder 2
N32	Injector, cylinder 3
N33	Injector, cylinder 4
N80	Activated charcoal filter system solenoid valve 1
N112	Secondary air inlet valve
N152	Ignition transformer
N156	Intake manifold change-over valve
S	Fuse
V101	Secondary air pump
A	Signal to self diagnosis fault warning lamp K83 (in models dating from 2000, this signal is transferred via the CAN bus)
B	Road speed signal from control unit with display unit in dash panel insert J285
C	CAN bus

Glossary

Adaption
Adapt to changed conditions.

D2, D3, D4
Exhaust emission standards of the Federal Republic of Germany
(refer to Self-Study Programme 230)

NEFZ (Neuer Europäischer Fahrzyklus)
New European driving cycle for determining the exhaust emissions of motor vehicles



Electrode
Interface between an electrical circuit and a liquid or gaseous environment
(e.g. exhaust gas, ambient air)

EOBD
Euro On-Board Diagnostics

EU II, EU III, EU IV
Exhaust emission standard of the European Union
(refer to Self-Study Programme 230)

Generic Scan Tool
(OBD visual display unit)
It must be possible to read out all emission-related faults which the EOBD has detected via the diagnosis interface with any OBD visual display unit.
The use of OBD visual display units for spot checks is also planned.

IWDS (Integrierter Wellendichtring-Sensor)
Integrated shaft sealing ring sensor

Lambda
(fuel-air ratio, λ)
Factor which describes the air concentration in the fuel/air mixture.

$\lambda<1.0$=rich mixture
$\lambda>1.0$=lean mixture
$\lambda=1.0$=theoretical optimal mixing ratio

Theoretically, λ is the air inflow rate to (theoretical) air demand ratio:
Air inflow rate / air demand = lambda λ

Lambda control value
The engine control unit calculates the lambda control value from the lambda probe signals and engine operating state (e.g. engine speed, engine load). Based on this value, the fuel/air mixture is altered until the optimum ratio for the operating state is achieved.

LSF
Lambda probe flat (step type lambda probe)

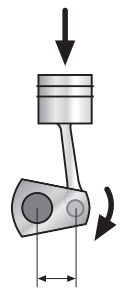
LSH
Lambda probe heating (finger probe)

LSU
Lambda probe universal (broadband lambda probe)

Modulation
To change or adapt the oscillation frequency of a signal.

Moment of force
The moment of force (better known as"torque") is the product of an applied force and the associated leverage.

Moment of force = force x leverage



Example with piston, connecting rod and crankshaft

Nernst cell
(part the of lambda probe)
The Nernst cell measures the differential between the oxygen concentrations in the ambient air and the exhaust gases and generates a corresponding voltage U. The Nernst cell comprises two electrodes, one on the ambient air side and and the other on the exhaust side.

OBD
On-Board Diagnostics

Pump cell
The pump cell comprises two electrodes separated by a ceramic material permeable to oxygen. The oxygen ions O_2 (negatively charged) are conducted through the ceramic from the negatively charged electrode (cathode) to the positively charged electrode (anode). The result is the so-called "pump effect".

Readiness code
8-character number code which indicates whether the OBD diagnoses of the vehicle systems were performed.

"0" - performed
"1" - not performed

SAE code
Fault code defined by the **S**ociety of **A**utomotive **E**ngineers and binding for all OBD systems.

Waste gate
(also known as "bypass")
The waste gate passes excess exhaust gases by the turbocharger drive. This allows the turbocharger to be deactivated or turbocharger power output to be reduced.

Test your knowledge

1. Until when can buyers register new cars without EOBD if the new cars meet exhaust emission standard D3?

☐ a) 31.12.1999

☐ b) 01.01.2000

☐ c) 31.12.2000

2. When does self diagnosis fault warning lamp K83 begin to flash?

3. What are the important points to note when replacing a broadband lambda probe (LSU)?

☐ a) The broadband lambda probe and the engine control unit are a system. Therefore, it is also necessary to replace the engine control unit.

☐ b) If the vehicle has two lambda probes, both probes must be replaced.

☐ c) The broadband lambda probe and the engine control unit are a system and must match one another.

☐ d) The broadband lambda probe may only be replaced complete with cable and connectors.

4. What is a Generic Scan Tool (OBD visual display unit) used for?

☐ a) The readiness code can be processed with it.

☐ b) Emission-related data, readiness codes, faults, fault conditions and vehicle data can be read out with it. In addition, fault and readiness codes can be cancelled.

☐ c) Emission-related data, readiness codes, faults, fault conditions and vehicle data can be read out with it. In addition, fault and readiness codes can be canceled and short trips can be performed.

Notes

Solutions:

1. c
2. If the catalyst can be damaged due to misfiring.
3. c, d
4. b

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